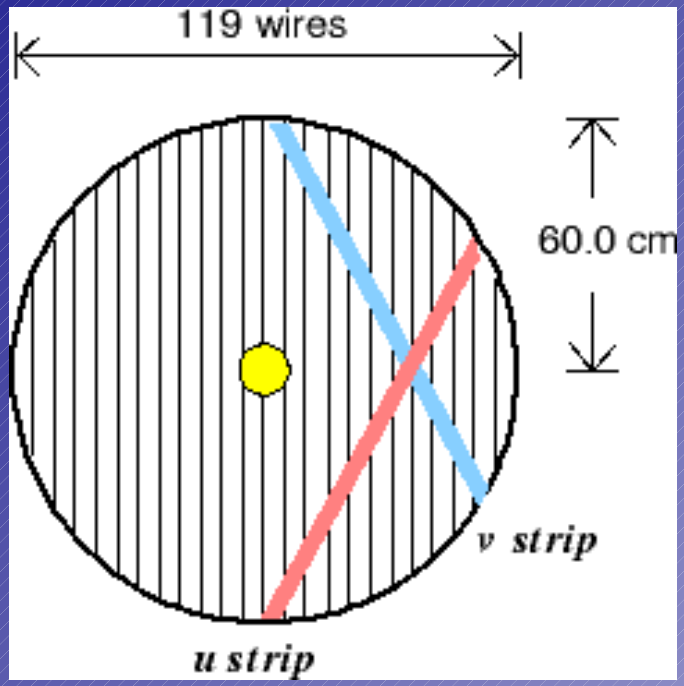
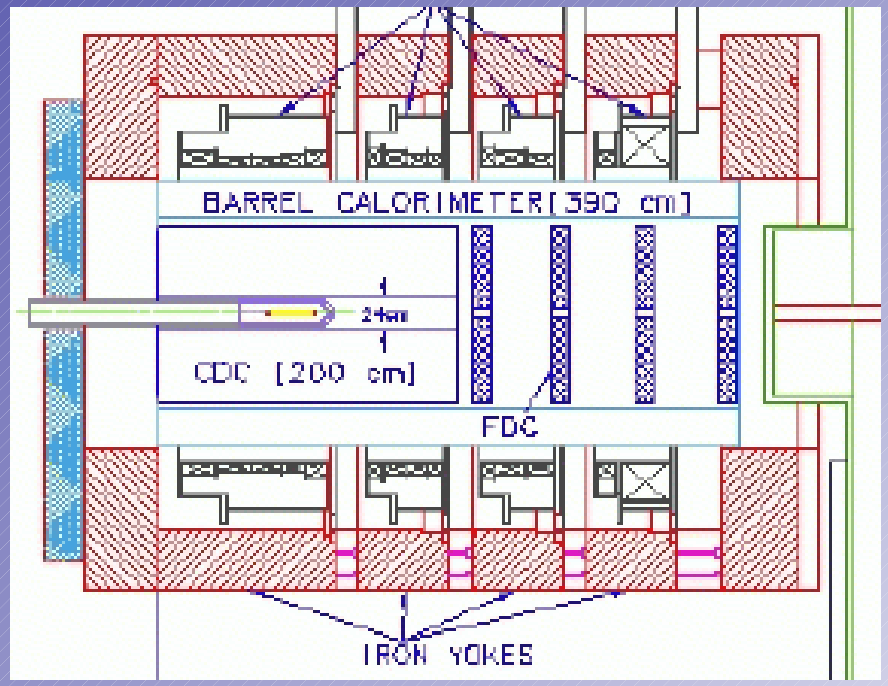
FDC Software Status





Simon Taylor
Ohio University

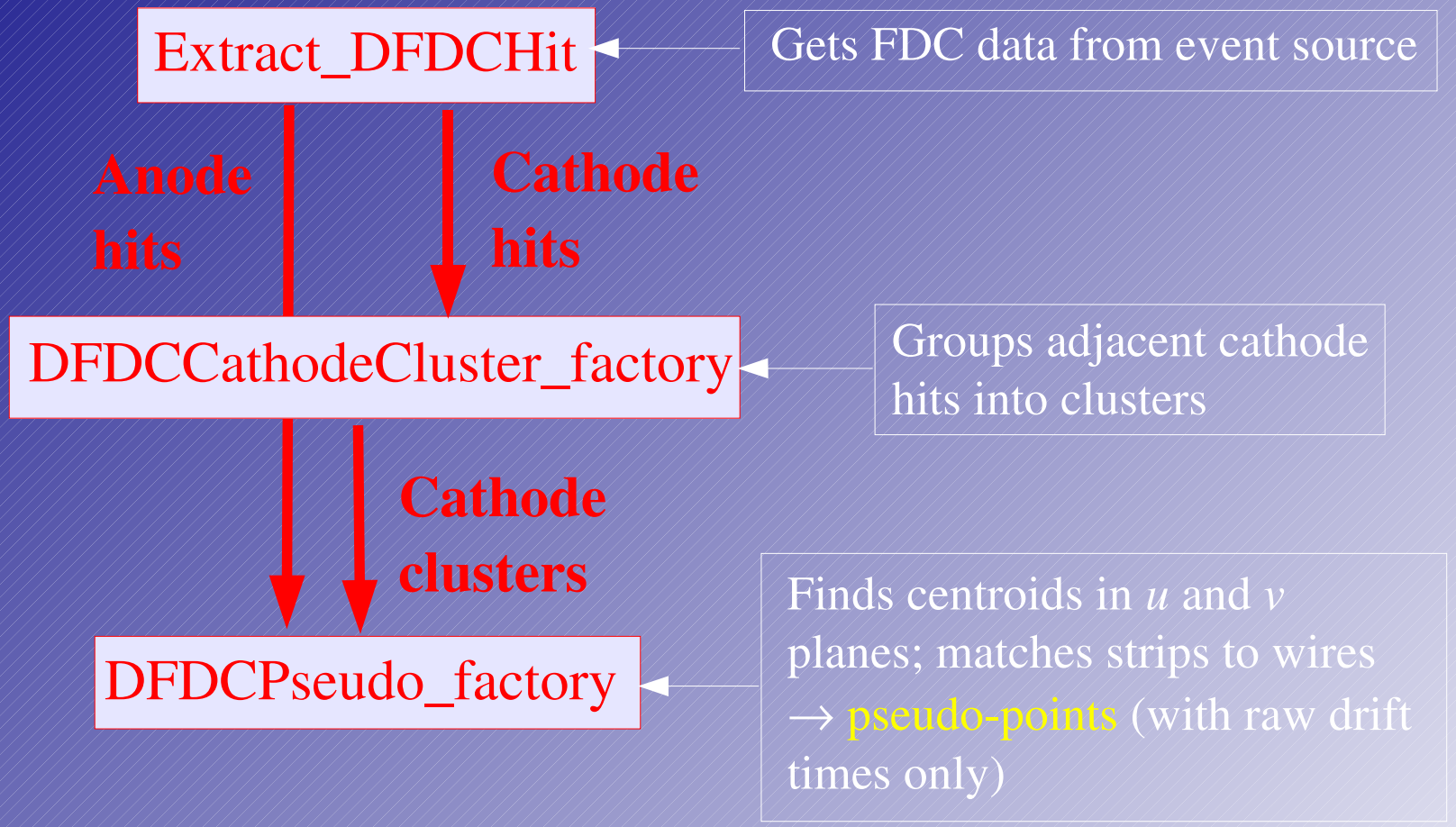
GlueX Software Workshop, November 2006

Status of FDC in HDGeant

- Drift regions / Kapton cathode planes / crude approximation for support frames implemented in *hdds* (detector geometry specification)
  - Wire count is not up-to-date with latest mechanical drawings
    - In code = 119 sense wires/plane → new count = 96 sense wires/plane
  - Support ring = 6 cm thick annulus of aluminum → should be G10
    - Need to check/fix dimensions (e.g. active area)
    - Support bars/rails between packages not included yet
- Anode signals based on energy loss in a cell
  - Approximation for statistical behavior = compound Poisson distribution
- Cathode signals distributed over multiple strips
  - Distribution = semi-empirical form derived from prototype data
  - Overlapping distributions added in overlap region
- Data model: {wire/strip (+u/v plane), dE (charge), t (time)}
  - Useful to have error information (significance of charge variation from strip to strip?)

Reconstruction Flow Chart

Code for creating "fuzzy" x,y,z points from cathode and wire data implemented in DANA framework:



Cathode Charge Distribution

- Semi-empirical formula due to Gatti, et al./Mathieson & Gordon:

$$\frac{\rho(\lambda)}{q_a} = k_1 \left(\frac{1 - \tanh^2(k_2\lambda)}{1 + k_3 \tanh^2(k_2\lambda)} \right),$$

k_1, k_2, k_3 are empirical constants

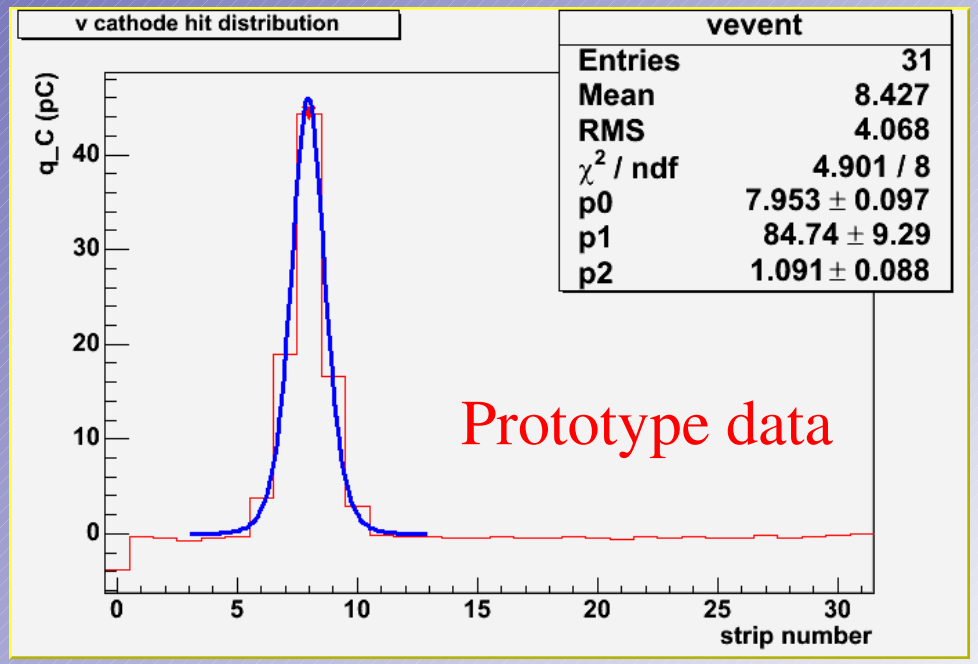
λ = normalized coordinate in cathode plane

q_a = charge on anode wire

- Prototype geometry: $k_3 \to 0$, $k_1 \to k_2/4$, $k_2 \approx 1$

$$\frac{\rho(\lambda)}{q_a} = \frac{k_2}{4} \left(1 - \tanh^2(k_2\lambda) \right)$$

Used this formula in HDGeant and FDC reconstruction



Centroid-finding algorithm

Use Newton-Raphson method to solve the following set of equations for charge q_a, width parameter K_2, and peak position x_p:

$$F_i = Q_i - \frac{q_a}{4}\left[\tanh\left(K_2\left(\frac{x_p - x_i + a}{h}\right)\right) - \tanh\left(K_2\left(\frac{x_p - x_i - a}{h}\right)\right)\right] = 0,\ i = 1..3.$$

Taylor Expansion:

$$F_i(\vec{x} + \delta\vec{x}) = F_i(\vec{x}) + \sum_{j=1}^{3} \frac{\partial F_i}{\partial x_j}\delta x_j + \mathcal{O}(\delta\vec{x}^2).$$

Estimate for correction:

$$\delta\vec{x} = -J^{-1}\vec{F},$$
$$J_{ij} \equiv \frac{\partial F_i}{\partial x_j}.$$

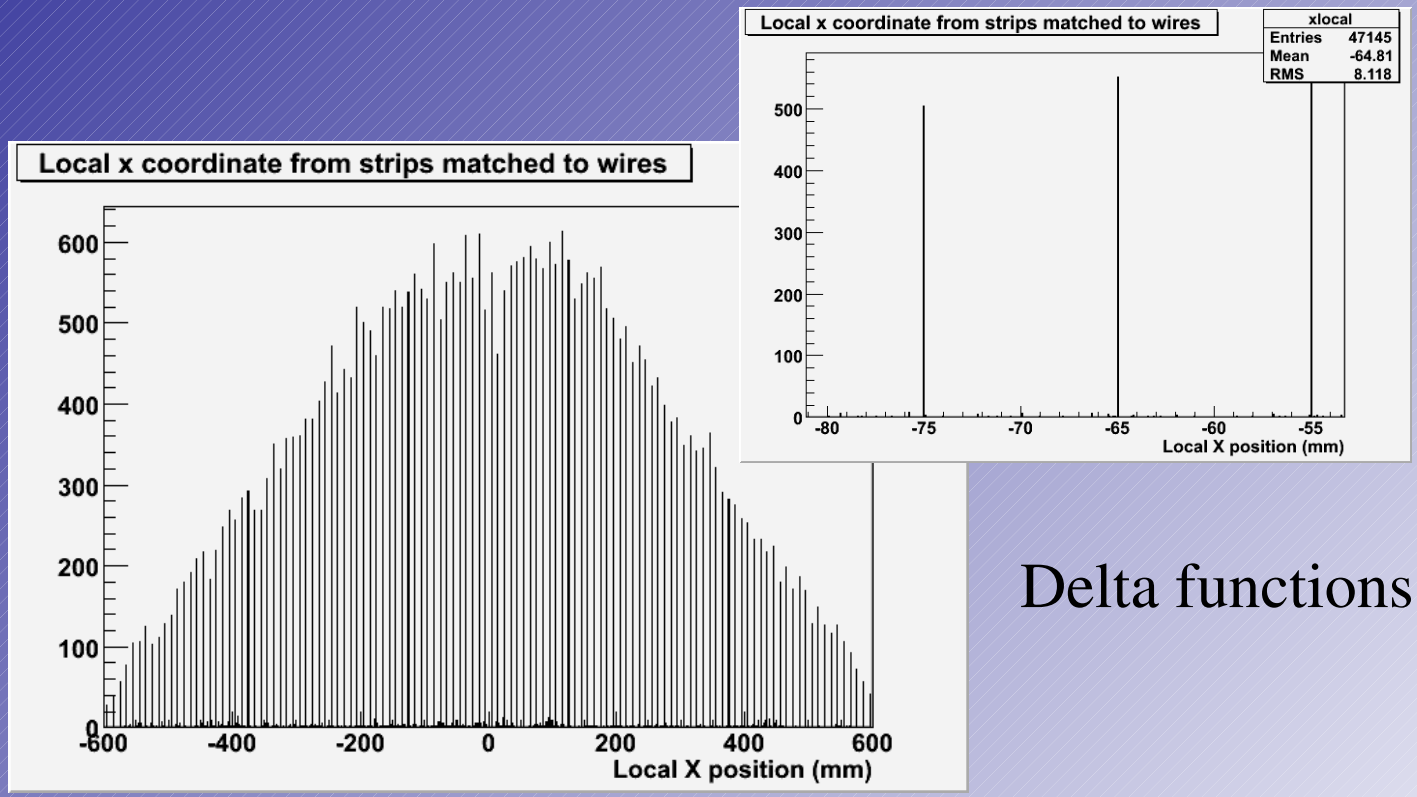
Iterate until

$$\sum_{j=1}^{3} |\delta x_j| < \delta x_{min} = 0.0001 \text{ or } \sum_{i=1}^{3} |F_i| < F_{min} = 0.0001.$$

Implemented in FDC code → DFDCPseudo_factory::FindCentroid( )

Reconstruction of MC events

- Generated $n\pi^+$ events ($E_\gamma = 9$ GeV with mostly forward-going pions)
- Ran through HDGeant with current simplified FDC geometry/material
  - No pedestal noise or background hits
- Reconstructed with FDC package in JANA/DANA framework
  - Use cathode strip data to reconstruct wire position (3 strips/view)



Delta functions...

Monte Carlo Studies for CD-2

- Check hermiticity of detector
  - Acceptance/Resolution vs. momentum vs. angle
  - Resolution/Acceptance for low multiplicity vs. high multiplicity events
- Effect of material type and density on detector resolution
  - Support frames, foam backing, cathode planes, cables, ...
  - Dead region around beam line
- FDC package placement
- Number of FDC packages and layers/package
- Effect of misalignment on resolution
  - Pitch, yaw, roll, translation
- Effect of dead channels (wire, strip, groups of wires/strips)